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DIGITALIZATION AS A FACTOR IN STRENGTHENING THE FINANCIAL SECURITY OF AGRICULTURAL ENTERPRISES

ЦИФРОВІЗАЦІЯ ЯК ЧИННИК ЗМІЦНЕННЯ ФІНАНСОВОЇ БЕЗПЕКИ АГРАРНИХ ПІДПРИЄМСТВ

Abstract. *Digitalization is an important factor in strengthening the financial security of agricultural enterprises, providing opportunities to improve information support, financial management, resource efficiency, cost optimization and financial analysis. The study identifies key digital technologies, including cloud computing, information systems, the Internet of Things, artificial intelligence, blockchain and cybersecurity solutions, as well as risks such as cyberattacks, unauthorized access, technical failures, data loss and modernization costs. The use of analysis, synthesis, comparison, systematization and generalization methods made it possible to substantiate the relationship between digitalization and financial security. It is concluded that effective digital transformation requires information protection, reliable digital infrastructure, qualified personnel and financial resources.*

Keywords: *digitalization, financial security, agricultural enterprises, digital technologies, financial risks, cyber threats, digital transformation, financial management.*

Анотація. Вступ. *Цифровізація дедалі більше стає важливим компонентом розвитку аграрних підприємств та впливає на організацію їх фінансових та управлінських процесів. Використання цифрових технологій створює додаткові можливості для вдосконалення інформаційного забезпечення, фінансового аналізу, управління ресурсами, оптимізації витрат та контролю за фінансовими потоками. Водночас зростання залежності від цифрової інфраструктури генерує нові ризики, пов'язані з кібератаками, несанкціонованим доступом до інформації, технічними збоями, втратою даних та потребою у відповідних цифрових компетенціях. Ці обставини зумовлюють актуальність дослідження цифровізації як чинника впливу на фінансову безпеку аграрних підприємств.* ***Метою статті*** *є визначення ролі цифровізації у зміцненні фінансової безпеки аграрних підприємств та обґрунтування напрямів мінімізації цифрових загроз у контексті економічного відновлення України.* ***Методи.*** *У дослідженні використано загальнонаукові методи пізнання, зокрема аналіз і синтез, індукцію та дедукцію, порівняння, систематизацію та узагальнення. Системний підхід застосовано для дослідження взаємозв'язку між цифровізацією, фінансовим менеджментом та фінансовою безпекою аграрних підприємств.* ***Результати.*** *У статті досліджено роль цифровізації у забезпеченні фінансової безпеки аграрних підприємств в умовах трансформації економічного середовища та повоєнного відновлення України. Обґрунтовано, що поширення цифрових технологій змінює підходи до управління фінансовими ресурсами, витратами та ризиками аграрних підприємств. Визначено основні цифрові інструменти, застосування яких сприяє підвищенню ефективності фінансового управління, зокрема автоматизовані інформаційні системи, хмарні технології, Big Data, штучний інтелект, Інтернет речей, блокчейн та цифрові платформи. Встановлено, що цифровізація створює можливості для підвищення прозорості фінансових потоків, оперативності фінансової аналітики, оптимізації ресурсного забезпечення, зниження непродуктивних витрат та підвищення обґрунтованості управлінських рішень. Окрему увагу приділено використанню цифрових технологій точного землеробства, супутникового моніторингу, систем прогнозування та інтелектуального аналізу даних як інструментів зниження виробничих і фінансових ризиків. Систематизовано основні ризики цифрової трансформації аграрних підприємств, серед яких кіберзагрози, ризики втрати або спотворення інформації, технічні збої, недостатній рівень цифрової інфраструктури, дефіцит кваліфікованих кадрів, висока вартість технологічного оновлення та регуляторна невизначеність. Обґрунтовано необхідність комплексного підходу до управління зазначеними ризиками шляхом поєднання технологічних, фінансових, організаційних та інфраструктурних заходів. Доведено доцільність поетапного та адаптивного впровадження цифрових технологій з урахуванням масштабу діяльності, фінансових можливостей і рівня технологічної готовності аграрних підприємств. Визначено, що цифрова трансформація має розглядатися не лише як засіб технологічної модернізації, а як важливий компонент системи фінансової безпеки, здатний підвищувати фінансову стійкість підприємств та їх адаптивність до змін зовнішнього середовища.*

Ключові слова: *цифровізація, фінансова безпека, аграрні підприємства, цифрові технології, фінансові ризики, кіберзагрози, цифрова трансформація, фінансовий менеджмент.*

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Problem statement. The financial security of agricultural enterprises is shaped by a wide range of internal and external factors, among which the stability of financial flows, the efficiency of resource utilization, the ability to withstand financial risks, and the capacity to respond promptly to changes in the economic environment play a particularly important role [4; 14]. The specific features of agricultural production primarily include the seasonality of revenues and expenditures, the dependence of business performance on natural and market conditions, substantial working capital requirements, and the geographical dispersion of production processes. These factors place increased demands on the quality of financial management and the provision of adequate information to support decision-making.

Under such conditions, digitalization becomes important not only as a direction of technological modernization of an enterprise but also as a tool for improving processes related to the formation, utilization, and control of financial resources. The application of digital accounting and management systems, electronic document management, analytical platforms, cloud-based services, big data processing tools, and other digital solutions can contribute to improving the timeliness of information acquisition, strengthening control over financial transactions, enhancing the soundness of managerial decisions, and ensuring a timely response to changes in the financial condition of an enterprise [9].

At the same time, digitalization does not eliminate financial threats and, in some cases, creates additional conditions for their emergence. The increasing dependence of financial and business processes on information systems enhances the significance of risks associated with cybersecurity, unauthorized access to data, technical failures, loss or damage to information, errors in the integration of digital systems, as well as insufficient digital competencies among employees. For individual enterprises, the costs of implementing and maintaining digital solutions, along with unequal access to the relevant infrastructure, remain additional constraints.

This issue is of particular relevance to Ukrainian agricultural enterprises, whose operations are carried out amid considerable economic uncertainty and the need to ensure the resilience of production and financial processes. In this context, digital technologies should not be regarded as a self-sufficient prerequisite for enhancing financial security, but rather as a tool whose effectiveness depends on the way in which they are integrated into the enterprise management system, the level of information protection, the availability of qualified personnel, and the enterprise's ability to assess the risks associated with digitalization.

Therefore, it is important to investigate the relationship between digitalization processes and the enhancement of the financial security of agricultural enterprises, including identifying areas for the application of digital technologies in financial management, assessing the potential benefits and risks of digital transformation, and developing practical approaches to minimizing digital threats.

Analysis of the latest research and publications. The issues of enterprise financial security and business digital transformation have been addressed in contemporary academic research from a range of interrelated perspectives. A distinct body of research comprises studies in which financial security is viewed as an integral component of the enterprise management system, encompassing the identification of financial risks, prevention of crisis situations, and maintenance of an adequate level of financial stability.

Thus, T. Zhukova, I. Basanets, and I. Plikus [8] focus on ensuring the financial security of businesses in the context of its interrelationship with crisis management. This approach is particularly relevant to the study of agricultural enterprises, as it makes it possible to consider financial security not merely as the outcome of achieving certain financial indicators, but as a continuous process of identifying, assessing, and neutralizing potential threats.

The financial security of small businesses is examined by O. Osidach and B. Sarnavskyi [10], as well as by N. Bondarchuk and A. Pedko [1]. These studies emphasize the need to integrate financial security instruments into the overall enterprise management system. This perspective is also relevant to the agricultural sector, since an enterprise's financial risks cannot be effectively assessed in isolation from its operational activities, resource provision, and management processes.

Another line of research addresses the digital transformation of entrepreneurial activity and its impact on economic processes in Ukraine [11–12; 15]. Within this research area, digitalization is examined through the use of modern information technologies, changes in approaches to business process organization, and improvements in management efficiency. At the same time, for the purposes of studying financial security, it is important to consider not only the potential economic benefits of digital solutions, but also the risks arising from enterprises' growing dependence on digital infrastructure.

Thus, the analysis of the scientific literature indicates a substantial body of theoretical research in two interrelated areas: ensuring enterprise financial security and the digital transformation of economic processes. At the same time, the issue of their integration at the level of agricultural enterprises remains insufficiently explored, particularly with regard to how digital tools can affect financial stability and resource control, what benefits they can provide for financial risk management, and what new digital threats may emerge in the course of their application. This research gap highlights the need for further substantiation of the role of digitalization within the financial security system of agricultural enterprises.

The purpose of the article is to substantiate the role of digitalization in ensuring the financial security of agricultural enterprises, systematize the key opportunities for applying digital technologies in financial and managerial processes, and identify digitalization-related risks that may affect the level of enterprises' financial security, with a view to further substantiating directions for minimizing digital threats in the context of Ukraine's economic recovery.

The methodological basis of this study is founded on a combination of general scientific methods of cognition, which allowed for a comprehensive investigation of the research problem. Specifically, the methods of analysis and synthesis, along with induction and deduction, were employed to examine the theoretical foundations of digitalization and its impact on the economic environment of agricultural enterprises.

Furthermore, a systems approach was applied to thoroughly investigate the complex interrelationship

between digital transformation, financial management, and the overall financial security of agricultural businesses. The methods of comparison, systematization, and generalization were utilized to structure the diverse digital technologies available to the agricultural sector and to clearly categorize the associated cybersecurity and financial risks.

Presentation of the main research material. The rapid spread of information technologies is accompanied by deepening digital transformation across various spheres of economic activity, including the agricultural sector. The use of automated management systems, analytical platforms capable of processing large volumes of data, as well as artificial intelligence and blockchain technologies, is expanding the capacity of agricultural enterprises to improve the organization and management of their operations. At the same time, the dynamic nature of technological change requires agricultural business entities to be able to adapt promptly to new conditions, master innovative solutions, and ensure an adequate level of readiness to operate in a digital environment [2].

As the scale of economic activity increases and the structure of operational processes becomes more complex, the need to apply modern information technologies becomes increasingly well-founded [6]. The substantial volumes of information required for performing managerial and control functions make it difficult to ensure adequate efficiency through the use of human resources alone. This gives rise to the need for systematizing information, processing it promptly, and organizing information flows in a structured manner. It is for this reason that the search for appropriate technological solutions, their adaptation to the needs of a specific enterprise, and their practical implementation become of significant importance for improving management.

At the same time, the effectiveness of digital transformation largely depends on staffing capacity. The use of modern digital tools, in particular artificial intelligence, blockchain, and Big Data technologies, presupposes the availability of employees who possess the necessary knowledge, practical skills, and experience in working with such technologies. At the same time, the shortage of relevant specialists in the domestic labor market prompts enterprises either to allocate additional financial resources to training and developing their own personnel, or to engage external specialists. The latter option may also require substantial financial expenditure. While such costs are more affordable for large agricultural companies, for small and medium-sized enterprises they may become a significant constraint on digital development. In this regard, it is advisable to systematize the main digital technologies whose application is feasible in the operations of Ukrainian agricultural enterprises and which can be used to enhance the effectiveness of economic activity and the adaptation of enterprises to changes in the external environment. The relevant technologies and the expected outcomes of their use are presented in Table 1.

The agricultural sector is among those spheres of the national economy where technological renewal proceeds more slowly compared to high-technology types of economic activity. This is also reflected in the pace of digitalization of agricultural production, which is accompanied by a number of practical constraints. The specific features of the digital transformation of agricultural enterprises are determined by a combination of factors, among which the following can be distinguished: the regional conditions of agricultural production, the socio-demographic characteristics of rural areas, and the level of development and accessibility of the industry's information infrastructure (Fig. 1).

Given these features, digital technologies are also acquiring significant importance in the context of shaping the financial security of enterprises in Ukraine's agricultural sector. Their use is associated not only with the improvement of production processes but also with the expansion of opportunities for managing financial risks. The application of digital solutions creates preconditions for greater transparency of financial flows, improved resource management, a reduction in unproductive expenditures, and the maintenance of stable monetary operations amid a volatile external environment.

The influence of the digital environment on the activity of an agricultural enterprise extends beyond the direct organization of production and also encompasses strategic planning, cost management, and the analysis of financial indicators. The expanded use of digital technologies enhances the enterprise's capacity to search for and develop new markets, and also simplifies the processing of information needed to assess its financial condition. Of particular importance is the improvement in the quality of production process monitoring, since the prompt receipt of information makes it possible to respond more quickly

Table 1

Modern Technologies for the Digital Transformation of Agricultural Sector Enterprises

Technologies	Implementation Outcome
Cloud computing	Create the ability to store, process, and analyze significant volumes of data without the need for substantial investment in one's own infrastructure
Inventory management systems	Help maintain an optimal level of inventory and improve the efficiency of supply chain management
Information systems	Used for enterprise management, information analysis, and support for managerial decision-making
Industrial Internet of Things (IIoT)	Ensures the collection of data from equipment and devices for its subsequent analysis and use
Artificial Intelligence (AI)	Used for automating individual processes, analyzing information, and forecasting
Cybersecurity	Aimed at protecting the enterprise's information infrastructure and data from cyberattacks
Blockchain technology	Creates opportunities for enhancing the security and reliability of transactions and data exchange
Three-dimensional (3D) printing	Makes it possible to quickly produce prototypes, spare parts, and other necessary items

Source: compiled by the authors based on [5]

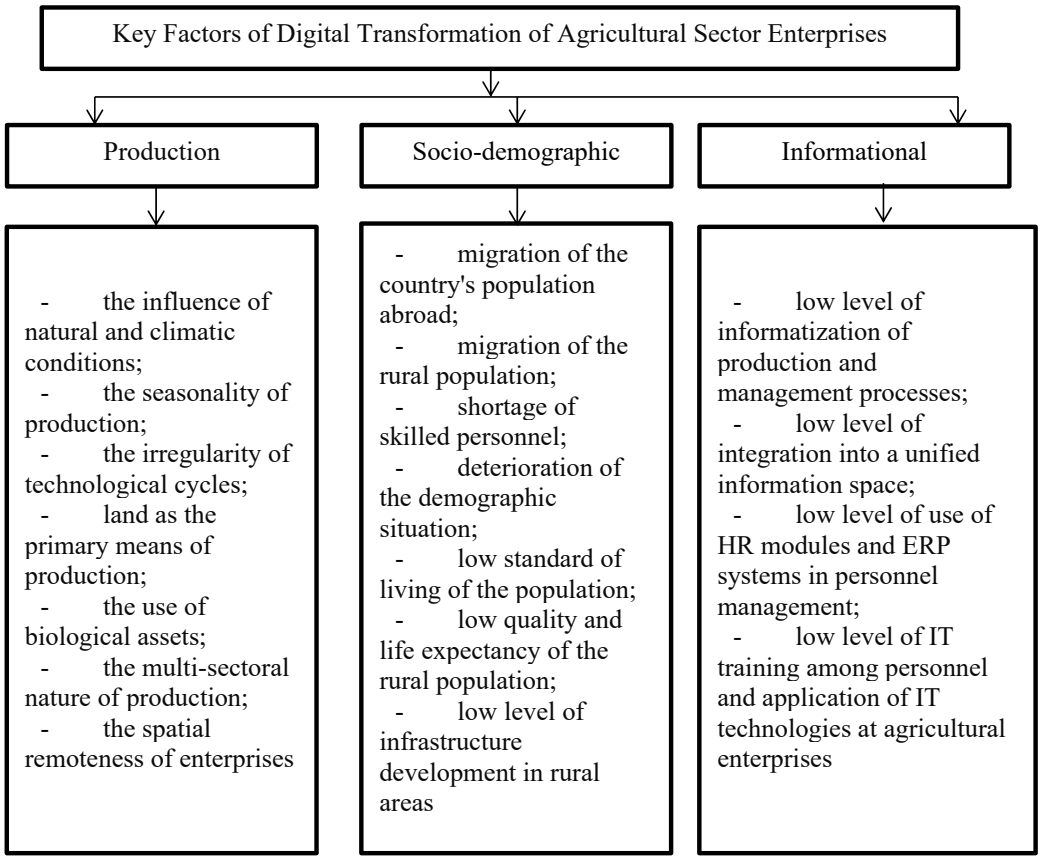


Fig. 1. Key factors in the development of digital technologies at agricultural sector enterprises

Source: compiled by the authors based on [15]

to changes and to prevent unnecessary losses. As a result, opportunities are created for the more rational use of material resources, the reduction of equipment downtime, and an increase in operational productivity.

One of the distinctive features of digitalization is the closer integration of material and information flows within an enterprise's production and financial system. The movement of resources may be accompanied by corresponding digital information regarding their purpose, direction, and timing of movement, which creates preconditions for reducing transaction costs. The systematic accumulation and processing of information, in turn, forms an information basis for the prompt adoption of managerial decisions and for responding to changes in the market situation. In this context, digital transformation may be aimed not only at reducing production costs but also at optimizing their structure across the entire agro-industrial chain and at generating added value on the basis of more coordinated management.

Changes are also occurring in the nature of agricultural enterprises' interaction with external counterparties. The openness of information systems creates the possibility for more prompt data exchange between economic entities, which contributes to greater transparency in their relationships and may reduce the likelihood of financial abuse. The formation of a unified information space, in turn, makes it possible to streamline internal managerial processes, reduce organizational costs, increase the reliability of information, and ensure its accessibility to interested parties.

Thus, the significance of digitalization for the financial security of agricultural enterprises manifests itself not in any single technological solution, but in the potential for the comprehensive improvement of the information, analytical, resource, and managerial support of their operations. Its potential is associated with expanding the enterprise's analytical capabilities, rationalizing costs, gaining access to new markets, and increasing the level of information openness in relations with partners, creditors, and state institutions.

At the same time, an assessment of the role of digitalization in strengthening financial security cannot be limited solely to its positive outcomes. The expansion of the digital environment simultaneously increases the number of factors capable of generating additional threats to the financial security of agricultural enterprises. This concerns, above all, the growth of information openness. In the absence of adequate protection, such openness may increase the vulnerability of information systems to external interference, including cyberattacks. The openness and accessibility of certain data sets may create opportunities for their use by competitors in order to gain strategic advantages. Under such conditions, an enterprise's information resource becomes not merely a means of ensuring management, but also a factor capable of affecting its competitive position and, accordingly, its financial security.

A separate group is constituted by risks associated with technical and software failures, as well as with prolonged power outages. Such situations may cause

partial or complete loss of data, disruption of production and logistics processes, and complications in the performance of operational tasks. A further danger is posed by the deliberate actions of third parties aimed at gaining unauthorized access to information systems and at copying, altering, or destroying data. The consequences of such actions may include not only direct financial losses but also a disruption of the integrity of managerial processes.

An equally important aspect is the human resource dimension of digital transformation. The growing complexity of technological processes and the use of modern digital solutions raise the requirements for employees' level of digital competence [7]. Accordingly, enterprises need to take into account the additional costs associated with training, professional development, and the upskilling of personnel.

Thus, the propositions set out above provide grounds for regarding the impact of digitalization on the financial security of agricultural enterprises as a two-sided process. On the one hand, digital technologies create opportunities for increasing the transparency of financial flows, improving resource management, automating reporting and analytics, enabling prompt information exchange, optimizing costs, and expanding market opportunities. On the other hand, the deepening of an enterprise's digital dependence is accompanied by risks of data loss or damage, cyberattacks, technical failures, unauthorized access to data, and the need for additional staffing support.

To more clearly illustrate the relationship described above, it is advisable to summarize the propositions established in the study in the form of a diagram (Table 2).

The table presented makes it possible to move from a separate consideration of technologies, benefits, and risks toward a comprehensive understanding of their interrelationship. It is important to note that digitalization in itself does not determine the level of an enterprise's financial security. Its impact is shaped by how effectively digital tools are integrated into the management system, how reliable the information base for decision-making is, whether adequate data protection is ensured, and whether the enterprise has the appropriate human resource capacity to use digital solutions.

For this reason, the further deepening of digital transformation at agricultural enterprises requires the simultaneous consideration of both its economic opportunities and its potential threats. For financial security, what becomes fundamentally important is not the maximal use of digital technologies as such, but their alignment with the enterprise's financial needs, available resources, personnel capabilities, and information protection requirements. Understood in this way, digitalization can be regarded as a factor capable of supporting the stability of agricultural enterprises' financial and economic activity and of enhancing their capacity to respond to changes in the external environment.

Conclusions. The conducted research makes it possible to consider digitalization as an important factor in strengthening the financial security of agricultural enterprises, provided that digital technologies are integrated into the existing system of financial and managerial processes. Their use expands the possibilities of obtaining and processing information, improves the transparency of financial flows, supports financial analysis and decision-making, contributes to more rational use of resources and creates additional opportunities for managing financial risks. The importance of these processes is particularly evident for agricultural enterprises, whose activities are characterized by significant dependence on changing market conditions and the need for timely management decisions.

The study shows that the potential of digitalization is realized through a range of interconnected technological solutions. Cloud computing, information systems, inventory management systems, industrial Internet of Things, artificial intelligence, blockchain, cybersecurity tools and other digital technologies can be applied in different areas of agricultural enterprises' activities. Their practical use is associated with improved information management, more efficient processing of financial data, optimization of resources and costs, faster interaction with counterparties and expansion of market opportunities. At the same time, the possibility of applying such technologies depends on the technological, financial and human resources available to the enterprise.

Table 2

The Relationship Between Digitalization and the Financial Security of Agricultural Enterprises

Area of Digitalization	Potential Impact on Financial Security	Associated Risks
Digital management and information systems	Increased efficiency of management and greater accessibility and reliability of information	Technical and software failures
Analytical digital tools	Improved analysis of financial indicators and support for managerial decision-making	Dependence on the quality and availability of data
Automation of financial processes	Increased accuracy and speed of processing financial information	Risks of disruption to the functioning of digital systems
Cloud technologies	Facilitating the storage, processing, and exchange of large volumes of information	Threats of unauthorized access to information
Digital exchange of information with counterparties	Increased transparency and reduced time for data exchange	Increased information openness
Cybersecurity	Protection of the enterprise's information infrastructure and data	The need to continuously maintain an adequate level of protection
Digital technologies in production and logistics processes	More rational use of resources and a reduction in unproductive expenditures	Dependence of production processes on technical infrastructure
Improving employees' digital competencies	Expanded capacity to make use of digital tools	Additional costs for training and professional development

Source: compiled by the authors based on [2; 3; 5; 6; 13; 15]

At the same time, digitalization should not be regarded exclusively as a source of positive changes in financial security. The increasing dependence of agricultural enterprises on digital infrastructure creates additional risks associated with cyberattacks, unauthorized access to information, technical and software failures, loss or damage to data, and interruptions in the functioning of production and logistics processes. The need to develop the digital competencies of employees also requires additional expenditure on training and professional development. For small and medium-sized agricultural enterprises, the financial burden associated with technological implementation and personnel development may become a significant constraint on digital transformation.

Therefore, in our opinion, the main challenge for agricultural enterprises is not simply the expansion of the use of digital technologies, but the establishment of an appropriate balance between the opportunities they provide and the risks arising from their application. Strengthening financial security in the digital environment requires the integration of technological solutions into financial and managerial processes, reliable protection of information, attention to the continuity of digital systems, appropriate personnel support and consideration of the financial capacity of enterprises. Such an approach makes it possible to use digitalization not as an independent objective, but as an instrument for supporting the stability and resilience of agricultural enterprises and improving their ability to respond to changes in the external environment.

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